microns and (d) short pulse laser of about (1–100) nanoseconds for the ultraviolet lasers with wavelength of about (190–310) nm. For minimum thermal damage and minimum scars on the corneal surface after the LASE procedure, the preferred embodiments of this invention include a laser beam spot size of about (5–500) microns on the ablated sclera tissue. Depending on the pulse duration, beam spot size and wavelength, the laser energy per pulse needed for sclera ablation will be about (0.5–15) mJ on the corneal surface.

The preferred embodiments in FIG. 5 for the basic coagulation laser **16** to prevent or minimize the corneal bleeding during the LASE procedures include the following lasers at long pulse duration or continuous wave (CW): (a) visible lasers with wavelength of (500–690) nm, (b) infrared lasers at wavelength of about 0.98, 1.5, 2.0 and 2.9 microns, in which the corneal tissue absorption of these radiation will cause coagulation to occur. The preferred embodiments of the invention for the selected coagulation lasers include pulse duration of at least 100 microseconds and averaged power on the corneal surface of about (0.1–5.0) W, for spot size of about (0.1–1.0) mm. We note that the coagulation features of a laser are mainly governed by the long pulse duration and large spot size (or lower fluency) on the corneal surface. For a given wavelength longer than about 980 nm, a laser may be an ablative one or a coagulation one. When a laser is tightly focused, less than about 100 microns, the high fluency or peak power may start to perform ablative than coagulation in its interaction to tissues. For ultraviolet lasers shorter than 310 nm, however, coagulation effects will be minimum even at a large beam size.

FIG. **6** shows the LASE procedures performed by selected diode lasers or diode-pumped laser which are fiber-coupled on to the corneal surface. The basic ablative laser **19** is coupled to a fiber **21** and combined by another fiber jacket **23** with the coagulation laser **20** after it is coupled to a fiber **22**, where fibers **21** and **22** are highly transparent (better than 85% in about one meter long) to the wavelength of laser **19** and **20**, respectively. The combined output two wavelengths laser is then used to ablation and coagulate the sclera tissue to achieve ablation patterns to be described in FIG. **7**.

FIG. **7** shows the LASE patterns, where the selected lasers are focused onto the cornea surface around the limbus area **24**. Radial ablation patterns are performed in the anatomic limbus area of the sclera ciliary body. The ablation depth of the sclera ciliary tissue is about (400–700) microns with each of the radial length **25** of about (2.5–3.5) mm adjustable according to the optimal clinical outcomes including minimum regression and maximum accommodation for the presbyopic patients. The preferred radial ablation shall start at a distance about (4.0–5.5) mm from the corneal center out to the limbus area.

Referring to FIG. **7**, the preferred embodiments to generate the radial patterns on the sclera area include: (a) using the computer controlled scanning mirrors which move in x and y directions; (b) using a mechanical translator which is attached to the fiber end of the coupled ablative and coagulation lasers and cause the lasers to move along the predetermined patterns, and (c) manually move the fiber-coupled lasers along a line to generate the linear patterns. For precise and controllable ablation depth of the sclera tissue, methods (a) and (b) are preferred.

We also propose that overlapping of the scanning or translating beam is preferred for smooth, uniform and controlled depth of the ablated sclera. Calibration on materials including PMMA plastic sheet is preferred in order to clinically pretest the ablation depth of the sclera tissue. Measurement the depth of the ablated sclera tissue can be conducted by preset diamond knife instrument or ultrasound.

In this invention, we define the refractive surgeries by performing either PRK for corneal surface ablation or LASIK for intrastroma ablation and in general we name these procedures as corneal reshaping. The presbyopia correction, however, is referred as the removal of the sclera tissue.

While the invention has been shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes and variations in form and detail may be made therein without departing from the spirit, scope and teaching to the invention. Accordingly, threshold and apparatus, the ophthalmic applications herein disclosed are to be considered merely as illustrative and the invention is to be limited only as set forth in the claims.

I claim:

1. A method of performing refractive surgery by reshaping a portion of corneal tissue, said method comprising the steps of:

selecting a gas laser generated by transverse electrical discharge in a mixture of neural gases including at least helium gas and having a pulsed output beams of predetermined mid-IR wavelength of (2.7–3.2) microns;

selecting a beam spot controller mechanism, said spot controller consisting of an internal magentic coupler integrated inside the laser cavity having a pin-hole size of about (2–10) mm;

focusing the output beam to a spot size of about (0.05–2.5) mm on the corneal surface;

selecting a scanning mechanism for scanning said selected laser output beam;

coupling said laser beam to a scanning device for scanning said laser beam over a predetermined corneal surface area to remove corneal tissue, whereby a patient's vision is corrected by reshaping the cornea.

2. A method of claim **1**, in which the hydration level of said corneal surface area is controlled by a gas blower such that a consistent tissue ablation rate can be achieved.

3. A method for improving presbyopic patient's vision by removing a portion of the sclera tissue from an eye of a patient, said method comprising the steps of:

selecting an ablative laser for removing sclera tissue by focusing said ablative laser to a spot size of about (5–800) microns on the corneal surface;

selecting a scanning mechanism for scanning said ablative laser;

coupling said ablative laser to a scanning device for scanning said ablative laser over a predetermined area outside the corneal limbus to remove said sclera tissue, whereby a patient's near vision is improved by the increase of the corneal lens accommodation.

4. A method of claim **3**, in which said ablative laser is a gas laser having an output wavelength of about (2.7–3.2) microns, energy per pulse of about (0.5–15) mJ on corneal surface and a pulse duration less than 150 nanoseconds.

5. A method of claim **3**, in which said ablative laser is a mid-IR solid-state laser having a wavelength of about (2.7–3.2) microns.

6. The method of claim **3**, in which said ablative laser includes pulsed radiation generated by transverse electrical

discharge carbon dioxide laser which is frequency-doubled into a laser having a wavelength of about (5.6–6.2) microns, energy per pulse of about (2–15) mJ on the corneal surface.

7. A method of claim 3, in which said ablative laser is a diode laser having a wavelength of about 980 nm.

8. A method of claim 3, in which said ablative laser is a diode laser having a wavelength of about (1.4–2.1) microns.

9. A method of claim 3, in which said ablative laser is a diode-pumped Er:YAG laser having a wavelength about 2.9 microns and a pulse duration less than 500 microseconds.

10. A method of claim 3, in which said ablative laser is an ultraviolet laser having wavelength of about (190–310) nm.

11. A method of claim 3, in which said sclera tissue is coagulated by a laser having a wavelength of about (0.5–3.2) microns, an average power of about (0.1–5.0) W on the corneal surface, spot size of about (0.1–1.0) mm, and a pulse duration longer than about 200 seconds.

12. A method of claim 3, in which said ablative laser is fiber-coupled and combined with a coagulation laser and delivered to the corneal surface.

13. A method of claim 3, in which said sclera tissue is ablated in radial patterns having a length about (2.5–3.5) mm and a depth about (400–700) microns.

14. A method of claim 3, in which said sclera tissue is ablated in radial patterns by a computer-controlled scanning mechanism.

15. A method of claim 3, in which said sclera tissue is ablated in radial patterns by a translation mechanism.

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